

# Readme for GOES Satellite Location Data

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## 1 Summary

The 'goes-l2-orb1m' product consists of netCDF files with GOES satellite locations (ephemerides) at a 1-min cadence. Location information is provided in geographic (GEO) and Geocentric Solar Ecliptic (GSE) coordinates. The source of the location information is ASCII files obtained from <http://sscweb.gsfc.nasa.gov/>. Depending on the satellite, the NASA data is provided at either 1-min or a 3-min cadence for the GOES satellites. For NASA data with a 3-min cadence, we have linearly interpolated the data to a 1-min-cadence. Table 1 shows the 'goes-l2-orb1m' data which is available from the GOES 8-15 tab at <https://www.ngdc.noaa.gov/stp/satellite/goes-r.html>.

Table 1: Satellite ephemeris data.

Satellite	Years	NASA cadence [mins]
GOES-8	1994-2003	1
GOES-9	1995-1998	1
GOES-10	1997-2009	1
GOES-11	2000-2011	3
GOES-12	2001-2010	1
GOES-13	2006-2018	3
GOES-14	2009-2020	3
GOES-15	2010-2020	3

Annual files and files from start of mission through 2020 for the 'goes-l2-orb1m' product are available from the 'GOES 8-15' tab at <https://www.ngdc.noaa.gov/stp/satellite/goes-r.html>. Variables are listed in Table 2. Further metadata is provided in the netCDF attributes in the files.

Table 2: Variables in satellite location files.

Variable	Description	Units
time	Spacecraft UTC time, neglecting leap secs	secs since 2000-01-01 12:00:00*
geo_llr	Spacecraft GEO position (lat., long., radius)	[deg, deg, km]
gse_xyz	Spacecraft GSE position (x, y, z)	[km, km, km]
local_time	Spacecraft local time	hours
gse_local_time	Spacecraft GSE local time	hours

\* For satellites before GOES-11, time units are "secs since 1970-01-01 00:00:00".

Figure 1 shows the GEO latitude, longitude and radius for GOES-15. Major position changes can be seen on the longitude plots. Plot of GEO coordinates for other GOES satellites are shown in Section 2. Figure 2 shows GEO latitude in the original 3-min cadence data from NASA and the interpolated data. The linear interpolation produces small errors where the data is not linear with time. Figure 3 shows the variation of GSE coordinates over one day.

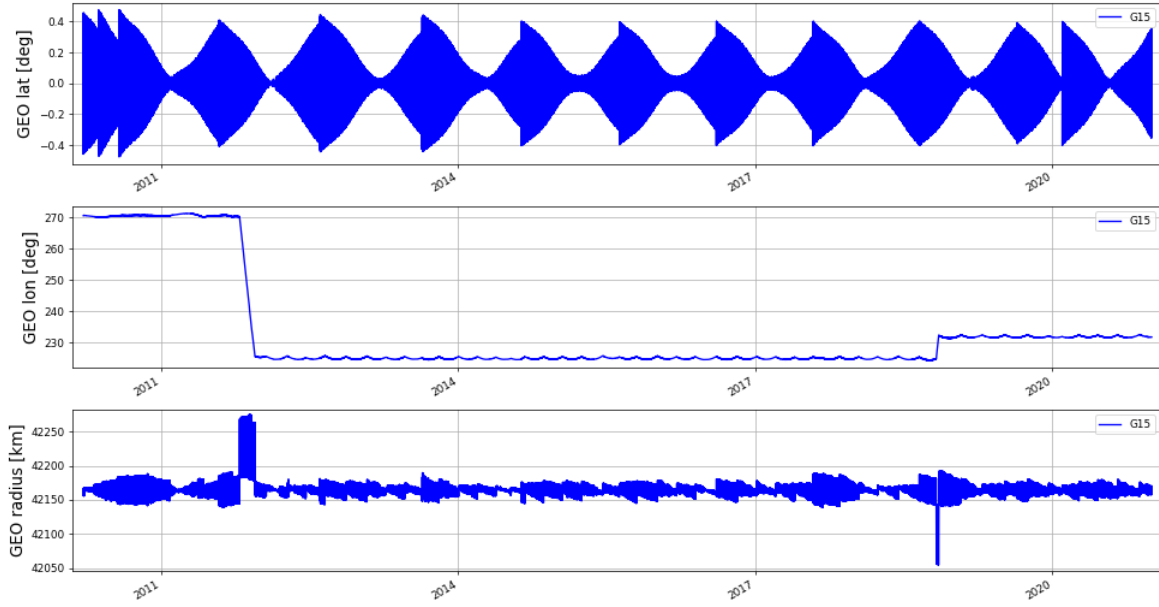


Figure 1: GEO latitude (top), longitude (middle) and radius (bottom) for GOES-15 satellite position.

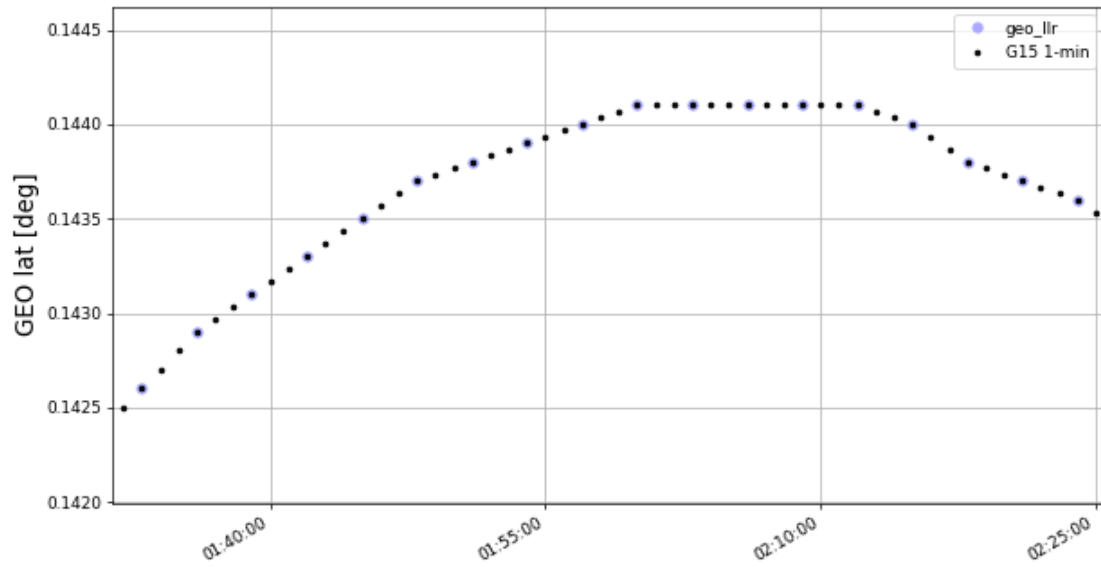


Figure 2: GEO latitude with 3-min cadence (large green dots) and 1-min cadence (black dots) data on GOES-15 on 2016-01-01. Errors due to the interpolation are most significant where the data has the most curvature.

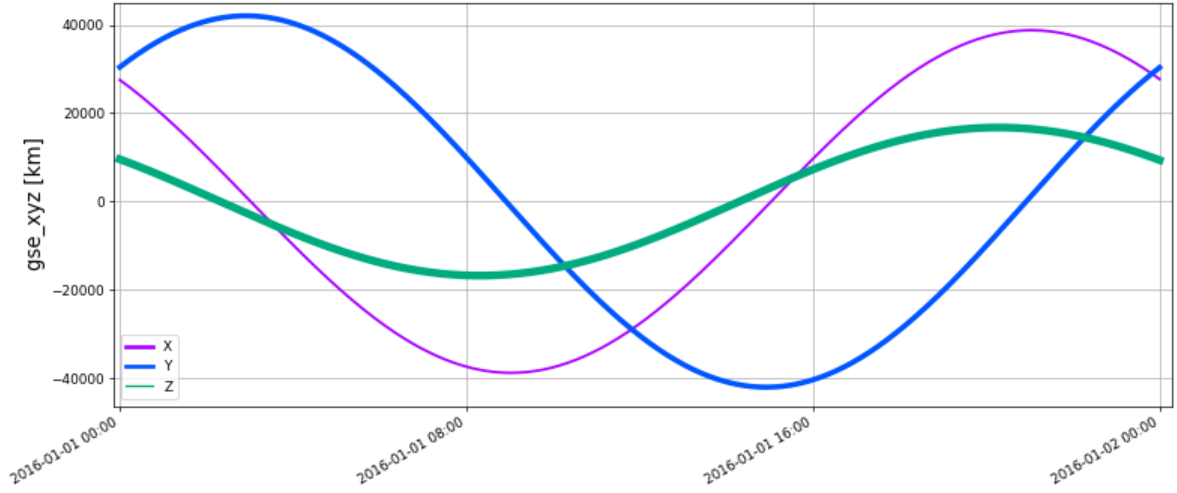


Figure 3: GSE X (purple), Y (green) and Z (blue) for GOES-15 satellite position for 2016-01-01.

## 2 Plots of Satellite Locations in GEO Coordinates

This section has plots of GEO latitude, longitude and radius for GOES-8 through -14. The GEO coordinates for GOES-15 are shown in Figure 1.

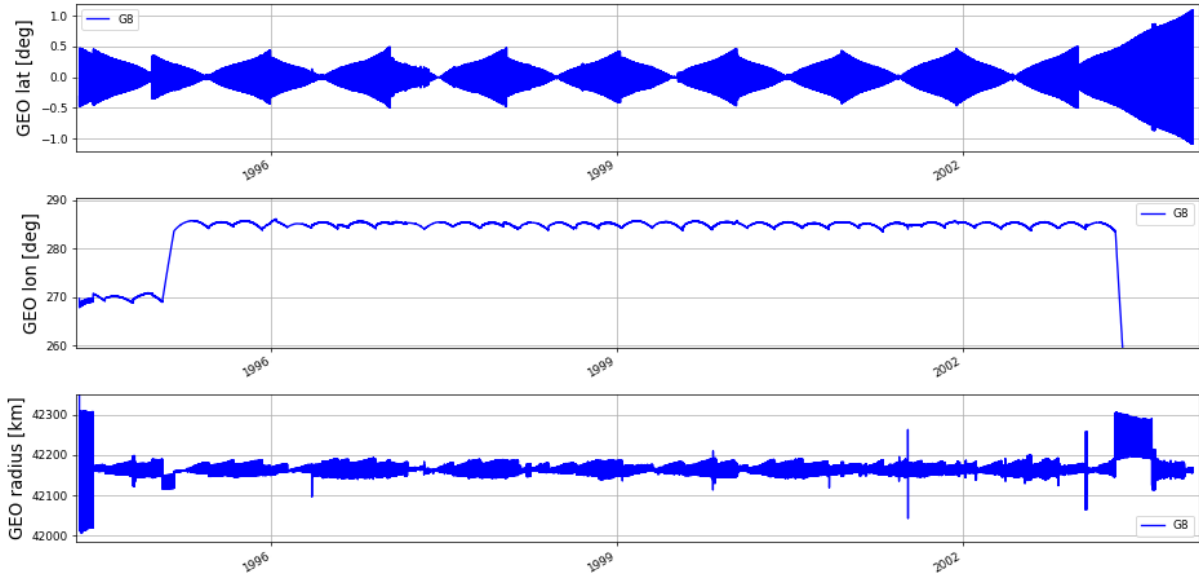


Figure 4: GOES-8 satellite position in GEO coordinates: latitude (top), longitude (middle) and radius (bottom).

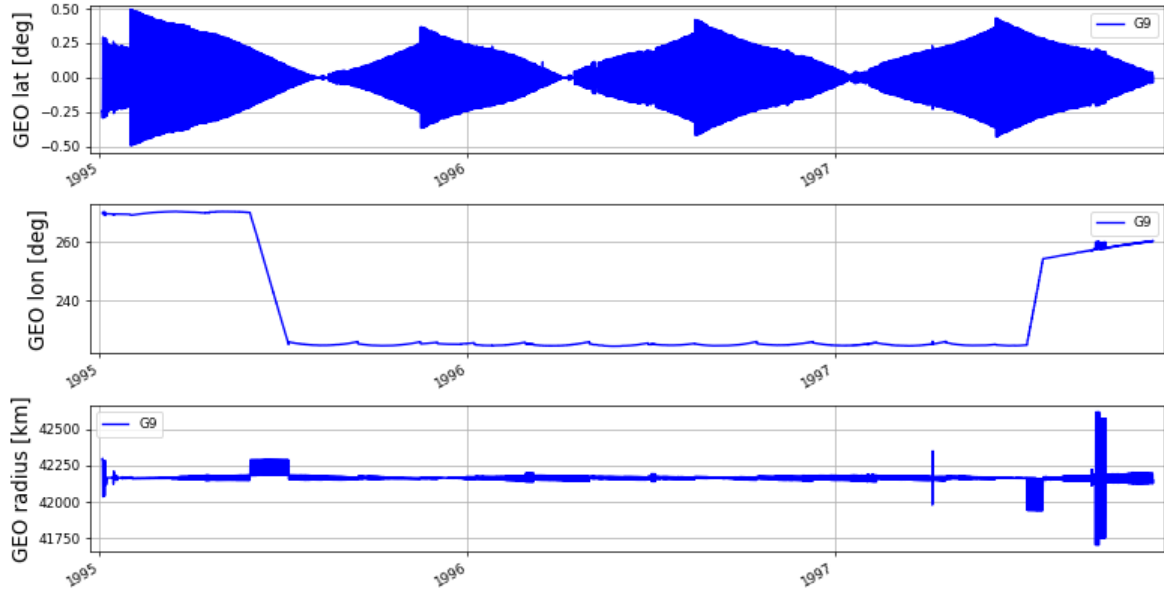


Figure 5: GOES-9 satellite position in GEO coordinates.

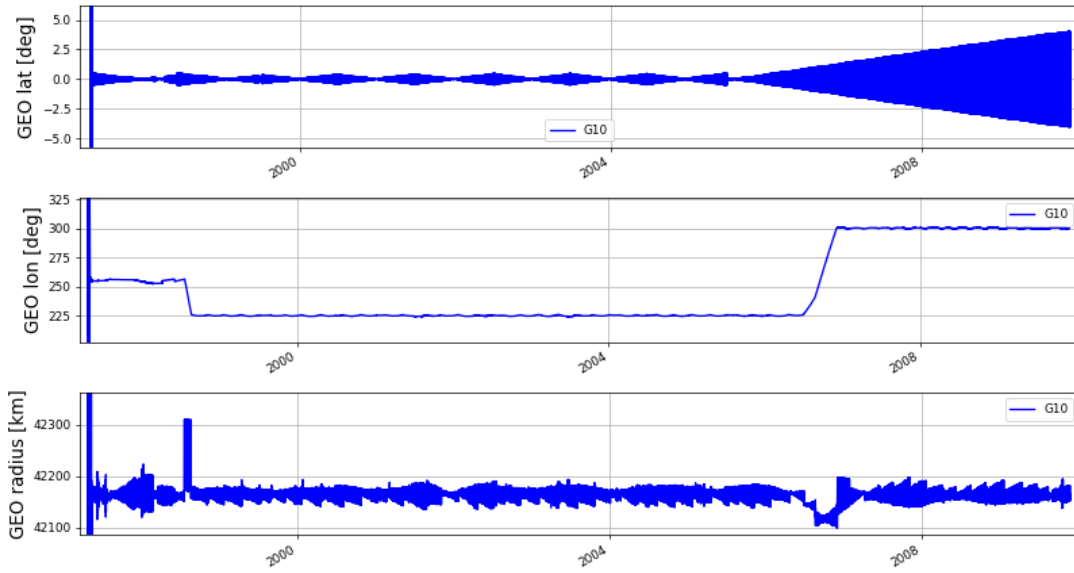


Figure 6: GOES-10 satellite position in GEO coordinates.

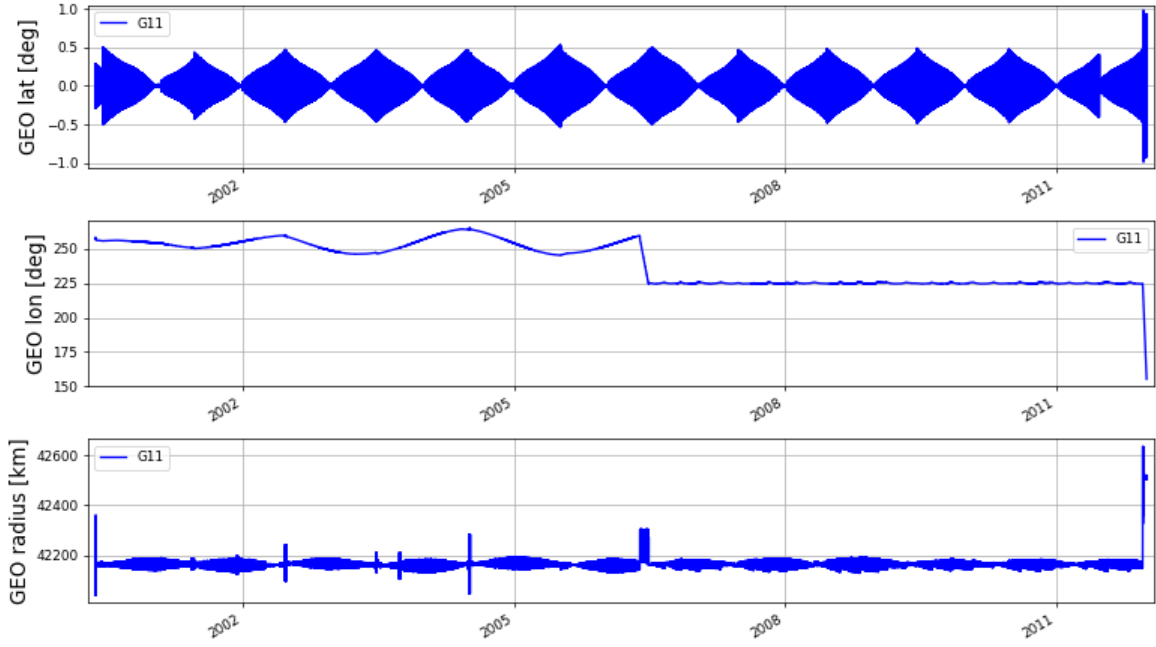


Figure 7: GOES-11 satellite position in GEO coordinates.

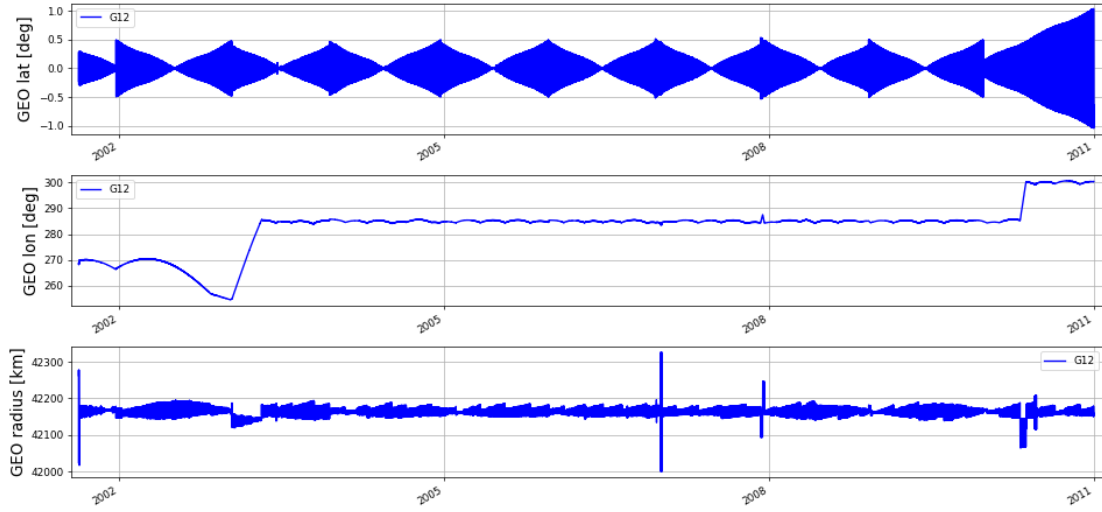


Figure 8: GOES-12 satellite position in GEO coordinates.

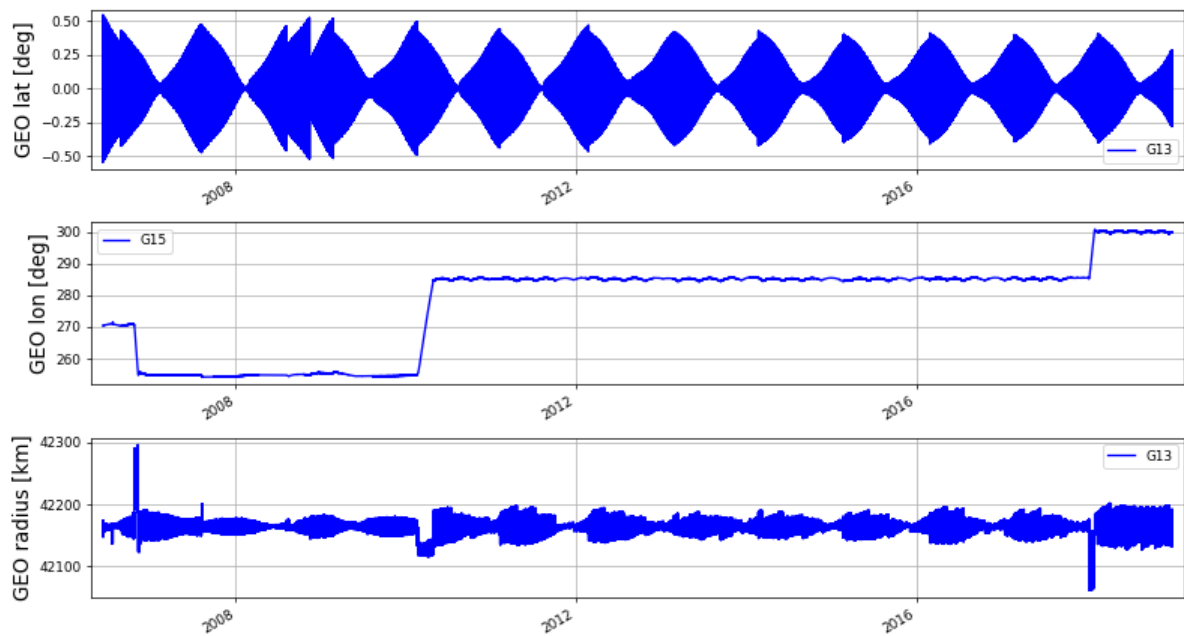


Figure 9: GOES-13 satellite position in GEO coordinates.

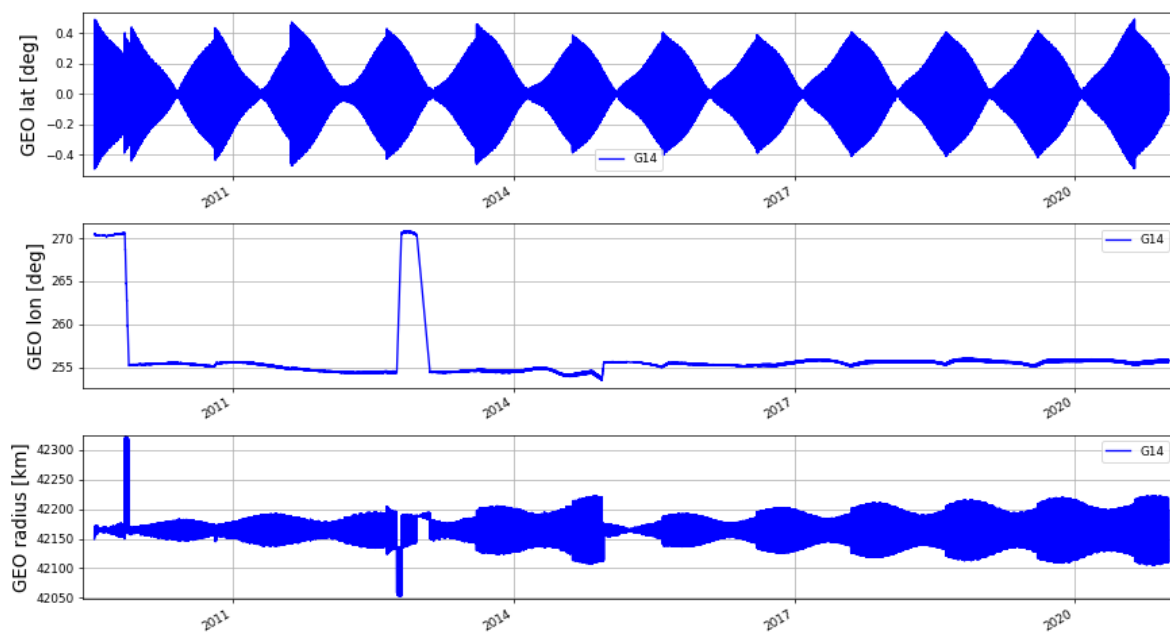


Figure 10: GOES-14 satellite position in GEO coordinates.